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Indian Standard

REQUIREMENTS FOR EQUIPMENT FOR JACKSON CANDLE TURBIDIMETER AND DETERMINATION OF TURBIDITY

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REQUIREMENTS FOR EQUIPMENT FOR JACKSON CANDLE TURBIDIMETER AND DETERMINATION OF TURBIDITY

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Indian Standard

REQUIREMENTS FOR EQUIPMENT FOR JACKSON CANDLE TURBIDIMETER AND DETERMINATION OF TURBIDITY

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 24 December 1981, after the draft finalized by the Public Health Engineering Equipment Sectional Committee had been approved by the Civil Engineering Division Council.

0.2 Turbidity is an important parameter or index in assessing the physical quality of water and the performance of the various treatment units in a water treatment system. Turbidity is also related to the aesthetic appearance of water.

0.3 Turbidity indicates the presence of extraneous matter in water, present in suspended or colloidal forms. Turbidity is basically an optical property of a sample which causes light to be scattered and observed, and optical techniques are used as measurement of turbidity.

0.4 In the formulation of this standard due weightage has been given to international co-ordination among the standards and practices prevailing in different countries in addition to relating to the practices in the field in this country.

0.5 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard lays down the requirements of equipment for Jackson candle turbidimeter and standards for measurement of turbidity.

*Rules for rounding off numerical values (*revised*).

2. PRINCIPLE

2.1 Turbidity measurement by Jackson candle turbidimeter is a visual method and is based on the light path through a suspension which first causes the flame of a standard candle to disappear — to become indistinguishable against the general background illumination — when the flame is viewed through the suspension. The longer is the light path, the lower shall be the turbidity.

2.2 Presence of rapidly settling debris and coarse sediments will interfere with the turbidity measurement. Dirty glassware, presence of air-bubbles and effects of vibrations that disturb the surface visibility of the sample will lead to false results.

3. UNITS OF TURBIDITY OR TURBIDITY MEASUREMENTS

3.1 Turbidity measurements by the candle turbidimeter are expressed as Jackson Turbidity Units (JTU). The Jackson Candle Method can be used for direct measurement of turbidity from 25 JTU to 1000 JTU, even though it is possible to measure higher turbidities with suitable dilutions. For turbidities less than 25 units, indirect secondary methods are employed.

3.2 Commercial turbidimeters are available for measuring low turbidities which are based on nephelometric principles and measure the intensity of light scattered in one particular direction, predominantly at right angles to the incident light. Turbidity measurements using nephelometers are expressed as Nephelometric Turbidity Units (NTU).

3.3 Formazin polymer, a standard reference suspension (*see* Appendix A) having reproducible light scattering properties is used for calibration of nephelometers. The turbidity of a given concentration of Formazin suspension is defined as 40 Nephelometric Units. This same suspension of Formazin has an approximate turbidity of 40 Jackson Turbidity Units (JTU), when measured on the Candle Turbidimeter. Therefore, Nephelometric Turbidity Units (NTU) based on Formazin will approximate Jackson Candle Turbidity Units (JTU).

4. APPARATUS

4.1 The standard candle turbidimeter, the basic instrument for measuring turbidity, shall consist of the following main parts:

a) Standard candle as a source of light;

b) Glass tube (turbidity tube) calibrated according to Table 1;

c) Tripod stand with the candle holder and a tube holder;

d) Bottles for visual comparison — A matched set of 1 litre capacity, glass stoppered bottles made of pyrex or other resistant glass.

4.2 Candle — The standard candle (*see* Fig. 1) shall be made of paraffin wax or beeswax and spermaceti with solidifying point (congealing point) 58 to 60°C. It shall be designed to burn within limits of 7·39 to 8·16 g per hour (114 to 126 grains/hour). Length of the candle shall be 150 mm to begin with and shall have a uniform diameter of 20 mm. The flame shall be kept as near constant and also at constant distance from bottom of the glass tube. The wick shall be so prepared that when the candle is burnt under suitable conditions, it shall burn with a clear, neatly white, *smokeless* and odourless flame.

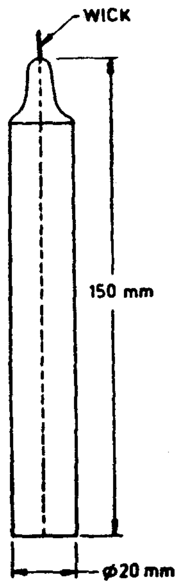


FIG. 1 TYPICAL SKETCH OF STANDARD CANDLE

To keep the candle pressed against the top of the candle holder which is 76 mm below the bottom of the tube a spring shall be used beneath the candle. The helical compression spring shall be made of spring steel conforming to IS : 4454 (Part I)-1975*. Before the candle is lighted each time, such portions of the burnt wick should necessarily be removed.

*Specification for steel wires for cold formed springs: Part I Patented and cold drawn steel wires—unalloyed (*first revision*).

4.3 Glass Tube — The glass tube called the turbidity tube shall be made of transparent, colourless and clean natural glass with *flat polish optically* plain parallel bottom without scratches or dots. When the tube is filled with the liquid and viewed from the top using a light source beneath the tube, there shall be no dark spots nor any lens like distortion of the transmitted light.

4.3.1 The tube shall be graduated in 1 mm division from 0 to 76 cm which corresponds to 25 to 1 000 turbidity units. The dimensions of the tube shall be as follows:

a) Internal diameter	25 mm
b) Total length	250 to 760 mm (different tubes for different ranges of turbidity).

4.3.2 The glass tube shall be enclosed in an annular metal tube when observations are being made, for the sake of protection against breakage and to exclude extraneous light. The annular tube shall be made of brass coated with chromium. When long turbidity tubes are used, an annular extension tube made of brass shall be used as an enclosure.

4.4 Tripod Stand and Support (see Fig. 2) — The support holds and aligns the candle and the turbidity tube. The candle and tube shall be supported in a vertical position so that the centre line of the tube passes through the centreline of the candle. The candle support shall consist of a spring loaded cylinder designed to keep the top of the candle pressed against the top of the support as the candle gradually burns away. The vertical distance from the bottom of the tube and the top of the support for the candle shall be 76 mm. A sketch indicating necessary details of the standard candle turbidimeter is shown in Fig. 3. The assembly bottom of the three legged tripod stand shall be made of cast iron while the legs shall be made of brass. The candle holder shall also be made of brass with chromium plating.

5. PREPARATION OF STANDARD SUSPENSIONS FOR VISUAL COMPARISON

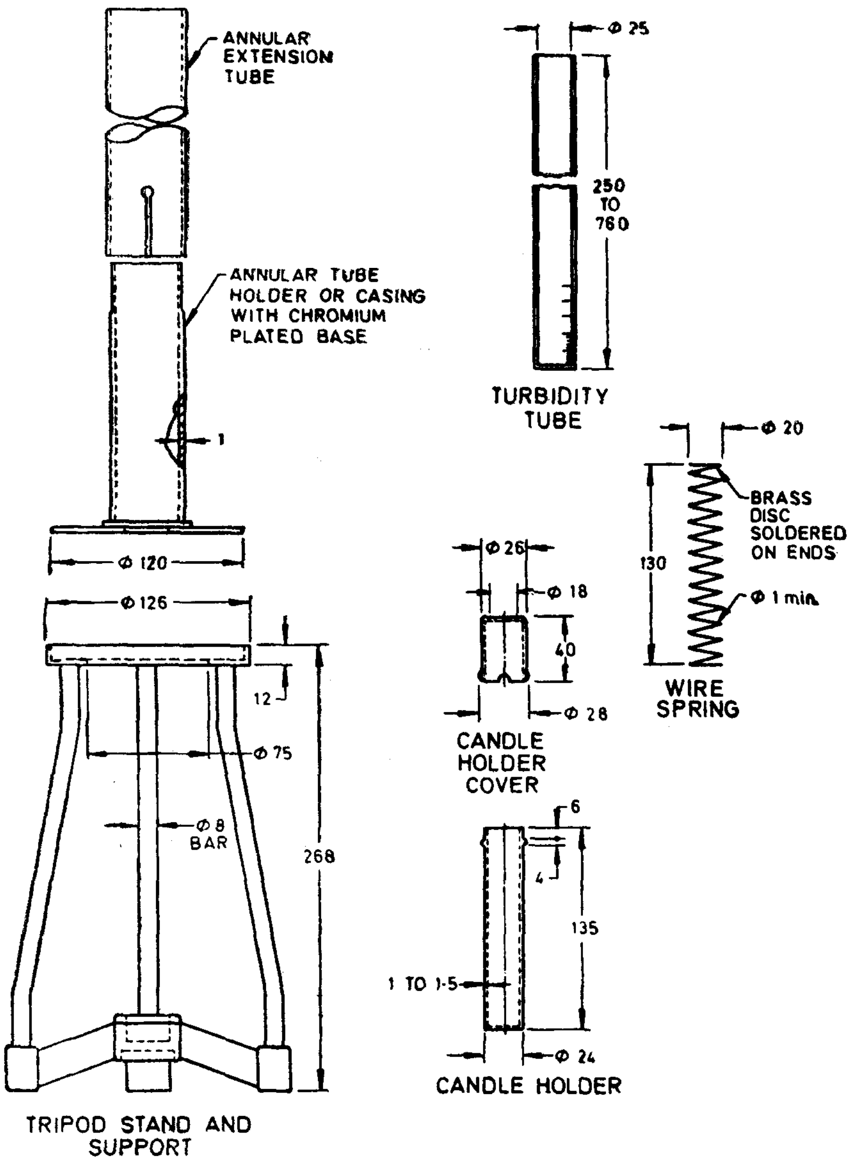
5.1 Visual comparison standards shall be prepared from natural turbid water or kaolin as per details given in Appendix B.

TABLE 1 GRADUATION OF CANDLE TURBIDIMETER

(*Clause* 4.1)

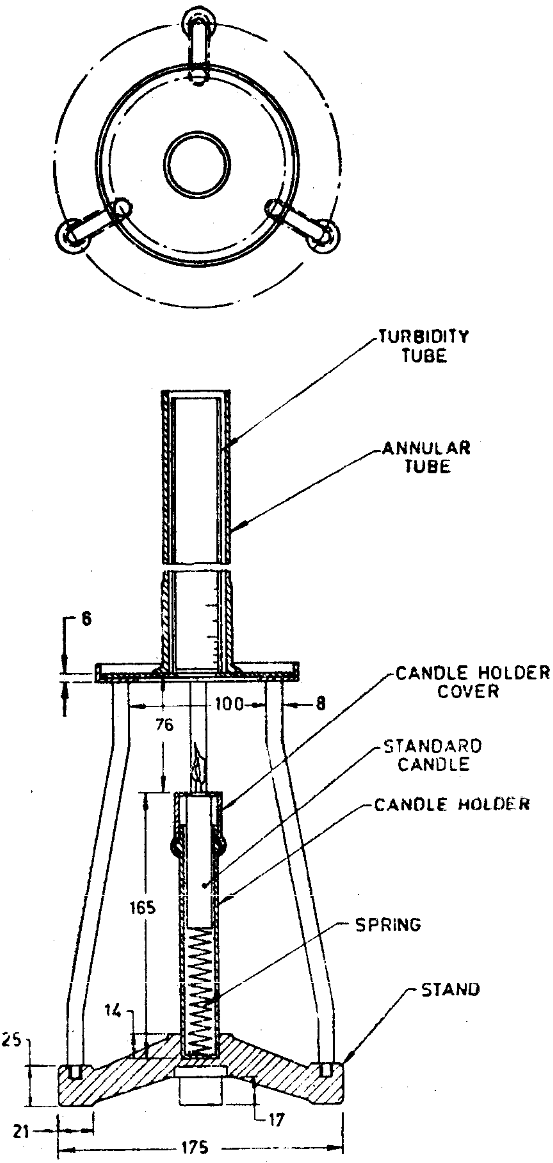
Light Path* cm	Turbidity Units	Light Path* cm	Turbidity Units
2·3	1 000	11·4	190
2·6	900	12·0	180
2·9	800	12·7	170
3·2	700	13·5	160
3·5	650	14·4	150
3·8	600	15·4	140
4·1	550	16·6	130
4·5	500	18·0	120
4·9	450	19·6	110
5·5	400	21·5	100
5·6	390	22·6	95
5·8	380	23·8	90
5·9	370	25·1	85
6·1	360	26·5	80
6·3	350	28·1	75
6·4	340	29·8	70
6·6	330	31·8	65
6·8	320	34·1	60
7·0	310	36·7	55
7·3	300	39·8	50
7·5	290	43·5	45
7·8	280	48·1	40
8·1	270	54·0	35
8·4	260	61·8	30
8·7	250	72·9	25
9·1	240		
9·5	230		
9·9	220		
10·3	210		
10·8	200		

*Measured from inside bottom of glass tube.



All dimensions in millimetres.

FIG. 2 JACKSON STANDARD TURBIDIMETER METER (DETAIL)



All dimensions in millimetres.

FIG. 3 JACKSON STANDARD TURBIDIMETER (ASSEMBLY)

APPENDIX A

(*Clause* 3.3)

STANDARD REFERENCE SUSPENSION

A-1. STOCK TURBIDITY SUSPENSION

A-1.1 Solution I — Dissolve 1·000 g hydrazine sulphate $(NH_2)_2.H_2SO_4$ in distilled water and dilute to 100 ml in a volumetric flask.

A-1.2 Solution II — Dissolve 10·00 g hexamethylene tetramine $(CH_2)_6N_4$ in distilled water and dilute to 100 ml in a volumetric flask.

A-1.3 In a 100 ml volumetric flask, mix 5·0 ml each of solution I and II. Allow to stand for 24 hours at 25 + 3°C, then dilute to the mark and mix. The turbidity of this suspension is 400 NTU.

A-2. STANDARD TURBIDITY SUSPENSION

A-2.1 Dilute 10·00 ml of stock turbidity suspension to 100 ml with turbidity free water. The turbidity of this water is defined as 40 NTU.

NOTE — Solutions I and II and stock suspensions should be prepared monthly. Standard turbidity suspension should be prepared weekly.

APPENDIX B

(*Clause* 5.1)

PREPARATION OF STANDARD SUSPENSION FOR VISUAL COMPARISON

B-1. STANDARD SUSPENSION

B-1.1 Natural Water — For best results, prepare from the natural turbid water from the same source as that to be tested. Determine turbidity with the candle turbidimeter, then dilute portions of the suspension to the turbidity value desired.

B-1.2 Kaolin — Add approximately 5 g kaolin to 1 litre distilled water, thoroughly agitate and allow to stand for 24 hours. Withdraw the supernatant without disturbing the bottom sediment. Determine turbidity with candle turbidimeter. Dilute portions of the suspension to the turbidity values desired. Preserve standard suspensions by adding 1 g mercuric chloride/litre suspension. Shake the suspensions vigorously before taking reading and check monthly with candle turbidimeter.

B-2. PROCEDURE

B-2.1 Estimation with Candle Turbidimeter

B-2.1.1 *Turbidities Between 25 and 1 000 JTU* — Pour the shaken sample into the glass tube until the flame of the candle just disappears from view. Make certain that a uniformly illuminated field with no bright spots materializes. Add the sample slowly towards the end. After the flame has been made to disappear, remove 1 percent of the sample with a pipette to make the flame visible again. Then add small amounts of the removed sample to approach the end-point more carefully. Keep the glass tube clean inside and outside and avoid scratching the glass. Accumulation of soot or moisture on the bottom of the tube interferes with the accuracy of the results. The experiment shall be carried out in a dark area, free from drought to avoid oscillation of flame.

B-2.1.2 *Turbidities Exceeding 1 000 JTU* — Dilute the sample with one or more volumes of turbidity-free water until the turbidity falls below 1 000 JTU. Compute the turbidity of the original sample from the turbidity of the diluted sample and the dilution factor. For example, if five volumes of turbidity-free water were added to one volume of sample and the diluted sample showed a turbidity of 500 JTU, the turbidity of the original sample was 3 000 JTU.

B-2.2 Estimation with Bottle Standards

B-2.2.1 In the range 5 to 100 JTU, compare shaken samples with standard suspensions made by diluting concentrated standard suspensions with turbidity-free water in known ratios. Place the sample and the standards in bottles of the same size, shape and type; leave enough empty space at the top of each bottle to allow adequate shaking before each reading. Compare the sample and the standard through the sides of the bottles by looking through them at the same object and noting the distinctions with which such objects as ruled lines or newsprint can be seen. Arrange the artificial lighting above or below the bottles so that no direct light reaches the eye. Record the turbidity of the sample as that of the standard that provides the visual effect most closely approximating that of the sample.

B-3. EXPRESSION OF RESULTS

B-3.1 Record the turbidity readings in the following manner:

Turbidity Range JTU	*Record to Nearest JTU*
0-1·0	0·1
More than 1-10	1
More than 10-100	5
More than 100-400	10
More than 400-700	50
700 or more	100

B-3.1.1 Identify the visual method (candle turbidimeter or bottle standards) used for the turbidity estimation.

(*Continued from page* 2)

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INTERNATIONAL SYSTEM OF UNITS (SI UNITS)

Base Units

QUANTITY	UNIT	SYMBOL
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Luminous intensity	candela	cd
Amount of substance	mole	mol

Supplementary Units

QUANTITY	UNIT	SYMBOL
Plane angle	radian	rad
Solid angle	steradian	sr

Derived Units

QUANTITY	UNIT	SYMBOL	DEFINITION
Force	newton	N	1 N = 1 $kg.m/s^2$
Energy	joule	J	1 J = 1 N.m
Power	watt	W	1 W = 1 J/s
Flux	weber	Wb	1 Wb = 1 V.s
Flux density	tesla	T	1 T = 1 Wb/m
Frequency	hertz	Hz	1 Hz = 1 c/s (s^{-1})
Electric conductance	siemens	S	1 S = 1 A/V
Electromotive force	volt	V	1 V = 1 W/A
Pressure, stress	pascal	Pa	1 Pa = 1 N/m^2